

1 Claims.

2

3 1. A material which shatters, when broken, into
4 fragments which do not cut, puncture or otherwise
5 damage human skin or tissue, wherein the material is
6 comprised of an amorphous thermoplastic polymer and
7 one or more low molecular weight resins.

8

9 2. A material as claimed in Claim 1 comprised of a
10 simple mixture of amorphous thermoplastic polymer
11 and one or more low molecular resins.

12

13 3. A material as claimed in any one of the proceeding
14 Claims wherein the amorphous thermoplastic polymer
15 is selected from the group consisting of polystyrene
16 (PS), polymethyl methacrylate (PMAA), styrene-
17 acrylonitrile copolymer (SAN), linear polyesters and
18 co-polyesters and polycarbonate (PC).

19

20 4. A material as claimed in any one of the proceeding
21 claims having a tensile stress limit between 11 and
22 60 Nmm⁻².

23

24 5. A material as claimed in any one of the proceeding
25 claims wherein the low molecular weight resin has an
26 Mn (number average molecular weight) such that it
27 has less than 500 repeating units.

28

29 6. A material as claimed in Claim 5 wherein the low
30 molecular weight resin has an Mn (number average
31 molecular weight) such that it has less than 50
32 repeating units.

33

- 1 7. A material as claimed in any one of the proceeding
2 claims manufactured in sheet form.
3
- 4 8. A polymeric blend comprising a polymer selected from
5 the group consisting of: polystyrene (PS),
6 polymethyl methacrylate (PMAA), styrene-
7 acrylonitrile copolymer (SAN), linear polyesters and
8 co-polyesters and polycarbonate (PC) and one or more
9 low molecular weight resins.
10
- 11 9. A polymeric blend as claimed in Claim 8 wherein the
12 one or more low molecular weight resins have an Mn
13 (number average molecular weight) such that it has
14 less than 500 repeating units.
15
- 16 10. A polymeric blend as claimed in Claim 9 when in
17 the one or more low molecular weight resins have an
18 Mn (number average molecular weight) such that it
19 has less than 50 repeating units.
20
- 21 11. A polymeric blend as claimed in any one of Claims
22 8 to 10 wherein the one or more molecular weight
23 resins are hydrocarbon resins.
24
- 25 12. A polymeric blend as claimed in Claim 11 wherein
26 the hydrocarbon resins are aromatic hydrocarbon
27 resins.
28
- 29 13. A polymeric blend as claimed in any one of Claims
30 8 to 12 manufactured in sheet form.
31
- 32 14. A material which shatters, when broken, into
33 fragments which do not cut, puncture or damage human
34 skin or tissue, the material being comprised of

1 polystyrene and one or more low molecular weight
2 resins.

3

4 15. A material as claimed in Claim 14 comprised of a
5 simple mixture of polystyrene and one or more low
6 molecular weight resins.

7

8 16. A material as claimed in any one of Claims 14 to
9 15 wherein the one or more low molecular weight
10 resins are hydrocarbon resins.

11

12 17. A material as claimed Claim 16 wherein the
13 hydrocarbon resins are aromatic hydrocarbon
14 resins.

15

16 18. A material as claimed in Claim 17 wherein the
17 aromatic hydrocarbon resins are C9 aromatic
18 hydrocarbon resins.

19

20 19. A material as claimed in any one Claims 14 to 18
21 wherein the one or more low molecular weight
22 resins are, or are derived from, alpha methyl
23 styrene.

24

25 20. A material as claimed in any one of Claims 14 to
26 19 wherein the one or more low molecular weight
27 hydrocarbon resins are selected from a group
28 consisting of; Norsolene™, Kristalex™, Plastolyn™,
29 Endex™, Piccotex™, Piccolastic™, Sukorez™ or
30 Arkon™.

31

32 21. A material as claimed in Claim 20 wherein the one
33 or more low molecular weight hydrocarbon resins
34 are selected from a group consisting of;

1 Norsolene W90™, Norsolene W100™, Norsolene W110™,
2 Kristalex F85™, Kristalex F100™, Kristalex F115™,
3 Plastolyn 240™, Plastolyn 290™, Endex155™,
4 Piccolastic D125™, Sukorez 100™, Sukorez 120™,
5 Arkon P100™, Arkon P125™, Arkon P140™, Piccotex
6 75™, Piccotex 100™ or Piccotex 120™.

7
8 22. A material as claimed in any one of Claims 14 to
9 21 wherein the one or more low molecular weight
10 resins have an Mn (number average molecular
11 weight) such that it has less than 500 repeating
12 units.

13
14 23. A material as claimed in Claim 22 wherein the one
15 or more low molecular weight resins have an Mn
16 (number average molecular weight) such that it has
17 less than 50 repeating units

18
19 24. A material as claimed in any one of Claims 14 to
20 23 having a tensile stress limit between 11 and 60
21 Nmm⁻².

22
23 25. A material as claimed in any one of Claims 14 to
24 24 which also includes one or more additives
25 selected from the group including UV inhibitors,
26 antioxidants, flow modifiers, fire retarding
27 agents, colour pigments and brighteners, and
28 oxygen scavengers.

29
30 26. A material as claimed in any one of Claims 14 to
31 25 manufactured in sheet form.

32
33 27. A method of manufacturing a material which
34 shatters, when broken, into fragments which do not

- 1 cut, puncture or damage human skin or tissue, the
2 method comprising the step of mixing an amorphous
3 thermoplastic polymer and one or more low
4 molecular weight resins.
5
- 6 28. A material as claimed in Claim 27 wherein the
7 amorphous thermoplastic polymer is chosen from the
8 group consisting of polystyrene (PS),
9 Polymethyl methacrylate (PMAA), styrene-
10 acrylonitrile copolymer (SAN), linear polyesters
11 and co-polyesters polycarbonate (PC).
12
- 13 29. A material as claimed in any one of Claims 27 to
14 28 wherein the one or more low molecular weight
15 resins are hydrocarbon resins.
16
- 17 30. A material as claimed in Claim 29 wherein the
18 hydrocarbon resins are aromatic hydrocarbon
19 resins.
20
- 21 31. A material as claimed in any one of Claims 27 to
22 30 wherein the low molecular weight resin has an
23 Mn (number average molecular weight) such that it
24 has less than 500 repeating units.
25
- 26 32. A material as claimed in Claim 31 wherein the low
27 molecular weight resin has an Mn (number average
28 molecular weight) such that it has less than 50
29 repeating units.
30
- 31 33. A material as claimed in any one Claims 27 to 37
32 wherein the glass transition temperature (T_g) of
33 the material is elevated as the amorphous

- 1 thermoplastic polymer is mixed with the one or
2 more low molecular weight hydrocarbon resins.
3
- 4 34. A material as claimed in Claim 33 when the T_g is
5 elevated to 5-10°C higher than the base polymer.
6
- 7 35. A method of manufacturing a material which
8 shatters, when broken, into fragments which do not
9 cut, puncture or damage human skin or tissue, the
10 methods comprising the step of mixing polystyrene
11 and one or more low molecular weight hydrocarbon
12 resins.
13
- 14 36. A method as claimed in Claim 35 wherein the one or
15 more low molecular weight resins are hydrocarbon
16 resins.
17
- 18 37. A method as claimed in Claim 36 wherein the
19 hydrocarbon resins are aromatic hydrocarbon
20 resins.
21
- 22 38. A method as claimed in Claim 36 wherein the
23 aromatic hydrocarbon resins are C₉ aromatic
24 hydrocarbon resins.
25
- 26 39. A method as claimed in any one of Claims 35 to 38
27 wherein the one or more low molecular weight
28 resins are, or are derived from, alpha methyl
29 styrene.
30
- 31 40. A method as claimed in any one of Claims 35 to 39
32 wherein the one or more low molecular weight
33 hydrocarbon resins are selected from a group
34 consisting of; Norsolene™, Kristalex™, Plastolyn™,

- 1 Endex™, Piccotex™, Piccolastic™, Sukorez™ or
2 Arkon™.
3
- 4 41. A method as claimed in Claim 40 wherein the one or
5 more low molecular weight hydrocarbon resins are
6 selected from a group consisting of Norsolene
7 W90™, Norsolene W100™, Norsolene W110™, Kristalex
8 F85™, Kristalex F100™, Kristalex F115™, Plastolyn
9 240™, Plastolyn 290™, Endex155™, Piccolastic
10 D125™, Sukorez 100™, Sukorez 120™, Arkon P100™,
11 Arkon P125™, Arkon P140™, Piccotex 75™, Piccotex
12 100™ or Piccotex 120™.
13
- 14 42. A method as claimed as in any one of Claims 35 to
15 41 wherein the low molecular weight resin has an
16 Mn (number average molecular weight) such that it
17 has less than 500 repeating units.
18
- 19 43. A method as claimed in Claim 42 wherein the low
20 molecular weight resin has an Mn (number average
21 molecular weight) such that it has less than 50
22 repeating units.
23
- 24 44. A method as claimed in any one of Claims 35 to 43
25 comprising the additional step of adding one or
26 more additives selected from the group consisting
27 of UV inhibitors, antioxidants, flow modifiers,
28 fire retarding agents, colour pigments and
29 brighteners and oxygen scavengers as known in the
30 art.
31
- 32 45. A method as claimed in any one of Claims 35 to 44
33 where the glass transition temperature (T_g) of the
34 material is elevated as the polystyrene is mixed

1 with one or more low molecular weight hydrocarbon
2 resins.

3

4 46. A method as claimed in Claim 45 wherein the T_g is
5 elevated to 5 to 10°C higher than the base
6 polymer.

7

8 47. A container manufactured from a material that
9 shatters when broken into fragments which do not
10 cut, puncture or otherwise damage human skin or
11 tissue.

12

13 48. A container as claimed in Claim 47 which is a
14 bottle.

15

16 49. A container as claimed in Claim 47 which is a
17 glass.

18

19 50. A container as claimed in Claim 47 which is a
20 tumbler.

21

22 51. A container as claimed in any one of Claims 47 to
23 50 wherein the material is a mixture of an
24 amorphous thermoplastic polymer and one or more
25 low molecular weight resins.

26

27 52. A container as claimed in Claim 51 wherein the
28 amorphous thermoplastic polymer is chosen from the
29 group consisting of: polystyrene (PS), styrene-
30 acrylonitrile co-polymer (SAN), linear polyesters
31 and co-polyesters polycarbonate (PC).

32

- 1 53. A container as claimed in Claim 51 wherein the one
2 or more low molecular weight resins are
3 hydrocarbon resins.
4
- 5 54. A container as claimed in A container as claimed
6 in Claim 53 wherein the one or more low molecular
7 weight resins are aromatic hydrocarbon resins
8
- 9 55. A container as claimed in Claims 53 to 54 wherein
10 the one or more low molecular weight hydrocarbon
11 resins are selected from a group consisting of:
12 Norsolene™, Krystalex™, Plastolyn™, Endex™,
13 Piccotex™, Piccolastic™, Sukorez™, Arkon™
14
- 15 56. A container as claimed in Claim 55 wherein the one
16 or more low molecular weight hydrocarbon resins
17 are selected from a group consisting of: Norsolene
18 W90™, Norsolene W100™, Norsolene W110™, Kristalex
19 F85™, Kristalex F100™, Kristalex F115™,
20 Plastolyn 240™, Plastolyn 290™, Endex 155™,
21 Piccolastic D125™, Sukorez 100™, Sukorez 120™,
22 Arkon P100™, Arkon P125™, Arkon P140™, Piccotex
23 75™, Piccotex 100™ or Piccotex 120™.
24
- 25 57. A container as claimed in any one of Claims 51 to
26 56 wherein the low molecular weight resin will
27 have a \overline{M}_n (number average molecular weight) such
28 that it has less than 500 repeating units.
29
- 30 58. A container as claimed in any one of Claims 51 to
31 56 wherein the low molecular weight resin will
32 have a \overline{M}_n (number average molecular weight) such
33 that it has less than 50 repeating units.

- 1
- 2 59. A container as claimed in any one of Claims 47 to
- 3 58 wherein the material has a tensile stress limit
- 4 between 11 and 60 Nmm⁻².
- 5
- 6 60. A container as claimed in any one of Claims 47 to
- 7 59 manufactured using injection blow moulding
- 8 and/or injection stretch blow moulding
- 9 techniques.
- 10
- 11 61. A container as claimed in any one of Claims 47 to
- 12 59 manufactured using extrusion blow moulding.
- 13
- 14 62. A container as claimed in any one of Claims 47 to
- 15 61 wherein the material contains an oxygen
- 16 barrier.
- 17
- 18 63. A container as claimed in Claim 62 wherein the
- 19 barrier included in the material is selected from
- 20 the group consisting of: acrylonitrile-methyl
- 21 acrylate copolymer, ethylene vinyl alcohol (EVOH)
- 22 or nylon MXD6.
- 23
- 24 64. A container as claimed in Claim 62 wherein the
- 25 barrier is Barex™.
- 26
- 27 65. A container as claimed in Claim 64 wherein the
- 28 barrier is Barex™ 210 or Barex™ 218.
- 29
- 30 66. A container as claimed in any one of Claims 62 to
- 31 65 wherein the barrier is overmoulded or sprayed
- 32 onto the container.
- 33

- 1 67. A container as claimed in any one of Claims 62 to
2 65 wherein the barrier is mixed with the material
3 of the container, using co-injection techniques.
4
- 5 68. A container as claimed in any one of Claims 47 to
6 67 wherein the material contains one or more
7 oxygen scavengers.
8
- 9 69. A container as claimed in Claim 68 wherein the
10 oxygen scavenger is selected from a group
11 consisting of X-312, Amosorb 3000, or a scavenger
12 of MXD6 with metal catalysed oxygen reduction
13 chemistry.
14
- 15 70. A container as claimed in any one of Claims 47 to
16 69 having an inorganic coating.
17
- 18 71. A container as claimed in Claim 70 wherein the
19 inorganic layer is a thin layer of amorphous
20 carbon.
21
- 22 72. A container as claimed in Claims 70 to 71 wherein
23 the inorganic coating is applied to the inside
24 surface of the container.
25
- 26 73. A container as claimed in any one of Claims 70 to
27 72 wherein the inorganic coating will be applied
28 in a layer of 100 to 200nm thickness.
29
- 30 74. A container as claimed in any one of Claims 47 to
31 73 having an external organic coating.
32

- 1 75. A container as claimed in Claim 74 wherein the
2 external organic coating is PVDC or a two
3 component epoxyamine.
4
- 5 76. A container as claimed in any one of Claims 47 to
6 75 manufactured from multiple layers of the
7 material.
8
- 9 77. A container as claimed in any one of Claims 47 to
10 76 wherein the material includes one or additives
11 selected from the group consisting of UV
12 inhibitors, antioxidants, flow modifiers, colour
13 pigments and brighteners as known in the art.
14
- 15 78. A container as claimed in any one of Claims 51 to
16 77 wherein the glass transition temperature is
17 elevated as the amorphous thermoplastic polymer is
18 mixed with the one or more low molecular weight
19 hydrocarbons.
20
- 21 79. A container as claimed in any one of Claims 51 to
22 78 wherein the material has a glass transition
23 temperature of above 80°C.